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USE OF DISCRIMINANT ANALYSIS IN A STUDY OF THE PATTERNS OF CHARACTERISTICS OF MATHEMATICS TEACHERS.

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DISCRIMINANT ANALYSIS, A PROCEDURE FROM MULTIVARIATE ANALYSIS, WAS UTILIZED IN A STUDY AND FOLLOW-UP OF 179 MATHEMATICS STUDENT TEACHERS. DISCRIMINANT ANALYSIS HAD ENOUGH POWER TO DISTINGUISH THE DIFFERENT PATTERNS OF CHARACTERISTICS OF FOUR GROUPS (SUCCESSFUL, UNSUCCESSFUL, EMPLOYED BY SCHOOL DISTRICTS BUT NOT TEACHING MATHEMATICS, AND THOSE WHO HAD LEFT TEACHING) AT THE ONE PERCENT LEVEL OF SIGNIFICANCE. (AUTHOR)

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USE OF DISCRIMINANT ANALYSIS IN A STUDY OF THE PATTERNS OF CHARACTERISTICS OF MATHEMATICS TEACHERS*

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Abstract

Discriminant analysis, a procedure from multivariate analysis, was utilized in a study and follow-up of 179 mathematics student teachers. Discriminant analysis had enough power to distinguish the different patterns of characteristics of four groups (successful, unsuccessful, employed by school districts but not teaching mathematics, and those who had left teaching) at the 1% level of significance.

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Use of Discriminant Analysis In A Study of The Patterns of Characteristics of Mathematics Teachers [1]

Problem

A shortage of secondary mathematics teachers has existed for many years.[2] The supply and demand of mathematics teachers is difficult to predict on a long-term basis because of the influence of various staff utilization plans, use of auxiliary personnel, teacher withdrawals, misassignment of teachers, etc. but the shortage trend probably will continue. The public, the government,[3] and institutions of higher learning are concerned that qualified teachers of mathematics be available for secondary school teaching. Of particular concern is the problem of teacher withdrawals. Does the existence of possible favorable job opportunities in industry for those with a background in mathematics tempt many teachers to leave mathematics teaching? In other words, what individuals are most likely to leave secondary mathematics teaching. Can they be identified before an investment of time, money, and institutional resources is allocated upon them? A sharper focus is thus needed on the problem of what is the pattern of characteristics of individuals who are likely to enter, continue, and succeed in teaching secondary mathematics and what is the pattern of characteristics of individuals who are likely to leave secondary school teaching.

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1 The research reported in this paper was supported by an Institutional Assistance Grant, Title V, Office of Education, U.S. Department of Health, Education, and Welfare.

2 National Education Association, Research Division. Teacher Supply and Demand in Public Schools, 1966. Research Report 1966-R16. Washington, D.C.: The Association, October, 1966, 80 pp.

3 See emphasis in the new legislation, The Education Professions Development Law, with the purpose of the title is to improve the quality of teaching and to help meet critical shortages of adequately trained educational personnel.

Research had indicated that there are differences among teachers in the different subject areas.[4] A pattern of characteristics that indicate a high probability of success for a mathematics teacher may not be the same pattern for the successful English teacher. The case study reported here focused on the patterns of characteristics of mathematics student teachers who had attended a state college and their subsequent occupational status.

Procedures

Sample

The sample chosen in this study included all 179 secondary student teachers (grades 7-12) from the period 1957-1966 who were classified as having a major or minor in mathematics and were enrolled in a teacher education program at a public state college. The sample of student teachers had already been screened according to the local standards of the institution in such areas as a minimum grade point average, an interview, speech clearance, etc. and the sample included no dropouts from the student teaching program. It should be recognized that the selection process undoubtedly had some influence on the type of student teachers found in the sample and another teacher education program's mathematics student teachers may be different. In particular, the number of females was probably lower than typically found.

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[4] Of interest to those who wish to know more about the characteristics of mathematics teachers see David G. Ryans. Characteristics of Teachers. American Council on Education, Washington, D. C., 1960., pp. 326-27.

Data on about 40 characteristics such as marital status, grade point average, professed avocational interests, supervisor's ratings, etc. were collected, classified, and key-punched for each student. These data were found in the personal confidential folders which were maintained on each student teacher by the teacher education program.

Follow-Up Phase

Extensive efforts were made through the use of Alumni Office records, the last previous address, parents address, use of directories of employed teachers, telephone books, etc. to try to locate the 179 mathematics student teachers in the sample. Although our culture has a highly mobile population, it was fortunate that one hundred and thirty six student teachers were located (78%) and their present employment status and the location of the school in which they were teaching ascertained (see Table 1).

Table 1. Follow-Up of Mathematics Student Teachers

	Males	Females	Total	Percentage
Number located	118	18	136	78%
Number unable to locate	28	15	43	22%
Total	146	33	179	100%

The proportion of females that could not be located compared to the proportion of males not located is significant at the 1% level computed on a binomial basis. Thus, the study is under-representing the female student teachers and this group may have a different pattern of characteristics.

Undoubtedly, many of the females in the sample have married and are using their married names which has made it difficult to trace them. However, it is possible to hypothesize that the female mathematics students are less likely to pursue a teaching career.

Criterion of Teacher Effectiveness, Principal's Ratings

Since the sample of mathematics student teachers was widely scattered geographically, the criterion measure for teaching effectiveness was a confidential rating scale mailed to the principal of the school in which the individual was presently teaching.[5] The principal was asked to rate the teacher on a scale from 1 to 5 (see Table 2) on ability as a teacher, indicate what classes the teacher taught, and mail back the confidential statement in a self-addressed stamped envelope.

Table 2. Ratings by Principals

Category	Number of Teachers	
1 -- Excellent	48	92 defined as successful (77% of ratings)
2 -- Very good	44	
3 -- Satisfactory	18	22 defined as unsuccessful (18% of ratings)
4 -- Poor	4	
5 -- No basis for judgment or no response from the principal	6	(5% of ratings)
Total	120	

[5] It is recognized that the definition used of a successful teacher in this study is arbitrary.

Analysis of Data

Discriminant Analysis - Pattern of Characteristics

The statistical procedure of discriminant analysis, a procedure from multivariate analysis, was the major technique attempted in studying the different patterns of characteristics of successful mathematics teachers, unsuccessful mathematics teachers, those employed by the school district but not teaching mathematics, and those who had left teaching at the secondary level. In discriminant analysis, a complex computational procedure [6] is used to obtain weights for each of the 40 characteristics on the teachers in the sample. These are then applied to compute a total score for the individual's characteristics, and this score was used with the criterion of teacher effectiveness, the principal's rating of their present-day teaching for those individuals who were presently engaged in teaching. For the individuals who were not teaching, of course, no principal rating could be used.

After extensive sorting through 40 variables, it was found that only a few variables contributed significantly to the discriminant analysis. One of the most significant variables was the college supervisor's ratings while the student teachers were doing their student teaching. Unfortunately, in the course of the ten year period, supervisors at the state college had neglected in some instances to place their reports into the confidential file of the student teacher. Therefore, all teachers who did not have supervisors rating data and also the six teachers who were in the category where the principal had not given a rating, were dropped from the analysis. This left

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6 Anderson, T. W., An Introduction to Multivariate Statistical Analysis. John Wiley and Sons, Inc., New York, 1958, pp. 147-52.

95 student teachers in the analysis and these were grouped into the four following categories as indicated in Table 3.

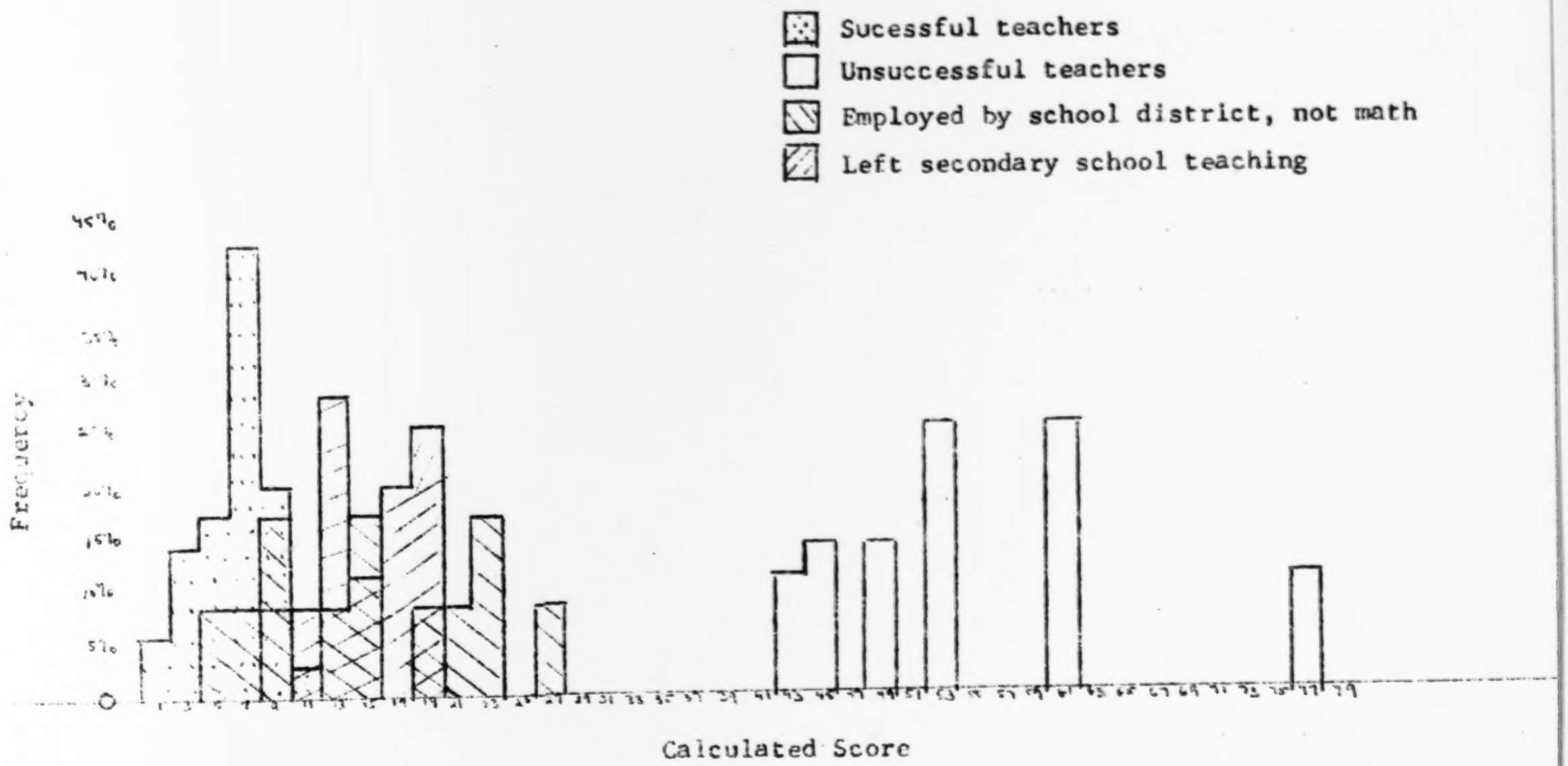
Table 3. Four Groups of Mathematics Student Teachers

Group	Number
1. Successful mathematics teachers who had received a rating of 1 or 2 from their principal	48
2. Unsuccessful mathematics teachers who had received a rating of 3 or 4 from their principal	16
3. Those who were employed by the school district but not teaching mathematics; these included administrators, counselors, or those teaching in a subject area other than mathematics	17
4. Those who had left teaching at the secondary level	14
Total	95

Discriminant analysis had enough power to distinguish the different patterns of characteristics of the four groups at the 1% level of significance (see Table 4). Of great interest is the fact that the unsuccessful teachers tended to have extreme scores. The differentiation between the successful teachers group and the other two groups (left teaching and employed by the school district but not teaching mathematics) tend to overlap more although the groups are still different. One hypothesis that could be made from this data is that the teachers who have left secondary school teaching have a closer similarity to successful teachers than to unsuccessful teachers. In other words, if most of them had stayed in teaching, they probably would have been rated as successful by their principals. It would appear that the teachers leaving secondary mathematics as a profession are a definite loss to the profession.

Although the number of teachers located who had left secondary school teaching was small (14) and it is hard to generalize from such a small sample, it only included two female student teachers who identified themselves as housewives.

Table 4. Calculated Frequency Distributions for the Four Groups in the Discriminant Analysis



The majority of individuals in the category "left secondary school teaching" were males and had accepted jobs in industry with an emphasis on the computer science field. This trend is probably true of mathematics teachers located in an urban-industrial environment.

The rank order of characteristics determined by discriminant analysis shows how much weight 24 of the variables contributed toward the score. Only a few contributed significantly to the score and this is indicated in Table 5. No single variable by itself is important but the pattern is significant in distinguishing the four groups. In general, the supervisor's reports on professional qualifications are contributing to high positive weights while the supervisor's reports on personal qualifications contribute negative scores to the weights. The detailed evaluation report that was used by the supervisors during student teaching is found in Table 6.

Summary

The statistical procedure of discriminant analysis was used in a follow-up study of mathematics student teachers at a state college. Discriminant analysis was used to obtain weights for characteristics such as married, grade point average, professed avocational interests, supervisor's ratings during student teaching, etc. These weights were applied to compute a total score for the individual's characteristics and this score was used with the criterion of teacher effectiveness, the principal's ratings of their present-day teaching which had been obtained from a follow-up procedure. Only a few variables contributed significantly to the score but the discriminant analysis had enough power to distinguish the patterns of characteristics of four groups (successful, unsuccessful, employed by the school district but not teaching mathematics, and those who had left teaching) at the 1% level of significance. Of extreme interest is the fact that the pattern of characteristics of teachers who have left the profession was different from the other groups but the scores were the closest to successful teachers.

This case study should be cross-validated to see if the pattern of characteristics would be similar in other groups of student teachers. At the present time, a working hypothesis is that the mathematics teachers who have left the profession would have been rated by their principals as successful and they are a real loss to the profession.

Table 5. Rank Order of Characteristics Determined by Discriminant Analysis

ccessful Teachers haracteristic	Weight	Left Secondary Teaching Characteristic	Weight
. Super.Report, Prof.Qual. No Pattern	9.9	1. Super.Report, Prof.Qual. No Pattern	11.7
. Super.Report, Prof. Qual. Strong	8.4	2. Super.Report, Prof. Qual. Ade.	5.8
. Super.Report, Prof. Qual. Ade.	8.2	3. Age at the time of the 5th year	4.7
. Public School Attended	3.4	4. Public School Attended	2.2
. GPA, 4 years	1.8	5. Super.Report, Prof. Qual. Strong	2.2
. Age at the time of the 5th year	1.5	6. Hobbies, leterary	1.5
. Hobbies, arts	0.5	7. Work experience part-time	1.1
. Member club, organ, high school	0.4	8. Member club, organ, high school	0.6
. Hobbies, social service	0.3	9. Honor Society in College	0.5
10. Hobbies, mechanical	0.1	10. Hobbies, Scientific	0.5
11. Hobbies, scientific	0.1	11. Hobbies, arts	0.1
12. Children	0.1	12. Political Activities	0.0
13. Super.Report, Prof. Qual. Weak	0.0	13. Male/female	0.0
14. Super.Report, Pers. Char. Weak	0.0	14. Super.Report, Pers. Char. Weak	0.0
15. Junior College Attended / yes or no	0.0	15. Super.Report, Prof. Qual. Weak	0.0
16. Political Activities	0.0	16. Junior College Attended/yes or no	-0.1
17. Male/female	0.0	17. Hobbies, social service	-0.2
18. Single/married	0.0	18. Children	-0.3
19. Hobbies, literary	-0.1	19. Hobbies, mechanical	-0.5
20. Honor Society in College	-0.1	20. Single/married	-0.5
21. Work experience part-time	-0.3	21. GPA, 4 years	-0.8
22. Super.Report, Pers.Char. No Pattern	-6.3	22. Super.Report, Pers. Char. Adequate	-4.4
23. Super.Report, Pers.Char. Adequate	-6.4	23. Super.Report, Pers. Char. Strong	-4.9
24. Super.Report, Pers.Char. Strong	-10.0	24. Super.Report, Pers. Char. No Pattern	-8.2

Table 6. Supervisory Report-Summary Evaluation

Strong
Adequate Key:
Weak

Personal Characteristics

Appearance	
Voice effectiveness	
Poise, self-confidence	
Forcefulness	
Judgment and tact	
Enthusiasm	
Cordiality and cooperation	
Industriousness and initiative	
Dependability	
Sense of humor	
Self control, patience	

Professional Qualifications

Attitude toward teaching	
Understanding of pupils	
Knowledge of subject	
Long range Planning	
Daily preparation	
Skill in methods	
Class management	
Skill in motivating	
Rapport with pupils	
Interest in Total school program	
Use of English	